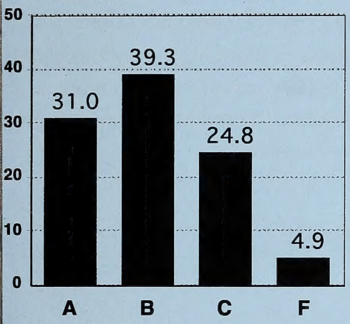
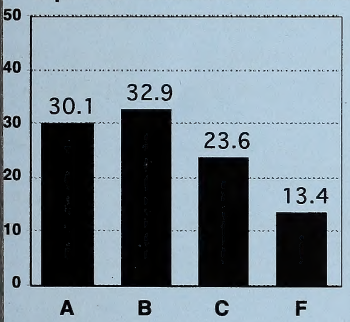
Physics 30

Diploma Examination Results
Examiners' Report for January 1994

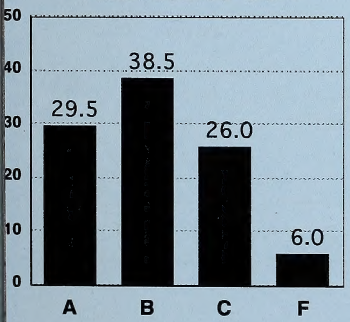
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1994 administration of the Physics 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Physics 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of four questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 3 086 students in Alberta who wrote the January 1994 examination. This represents a decrease of 131 students compared to January 1993. However, there was an overall increase in the number of students in the Physics 30 course because 314 students received final course marks in the revised (pilot) Physics 30 course. Since these pilot students did not write the January 1994 diploma examination, the information in this report does not include them.

- 94.0% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 29.5% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Physics 30 was satisfactory. Students demonstrated a good understanding of a broad range of physics concepts. Many students showed their willingness to take risks when solving problems by attempting all four written-response questions.

Students First!
Student Evaluation

Alberta
EDUCATION

Provincial Averages

- The average school-awarded mark was 71.2%.
- The average diploma examination mark was 69.0%.
- The average final course mark, representing an equal weighting o the school-awarded mark and the diploma examination mark, wa 70.1%.

The average examination mark achieved by females was 69.48% and b males 68.6%. Female students continued to score higher on knowledge questions that required recall of terminology, concepts, principles, generalizations, and theories. Male students scored higher on question where the application of a concept was involved.

Results and Examiners' Comments

Subtest: Machine Scored

When analyzing detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 35.63 out of 48

Course Content

- Light: 7.14 out of 10 (#8 has been dropped)
- Electric and Magnetic Fields: 9.78 out of 13
- Electromagnetic Radiation: 4.39 out of 6
- Structure of Matter: 10.68 out of 14
- Modern Physical Theories: 3.63 out of 5

Process Skills: 8.72 out of 13

- Multiple-choice questions 5, 7, 10, 20, 24, 32, 34, 36, 37, 38, 39, and numerical response questions 2 and 5.

Cognitive Levels

- Knowledge: 12.13 out of 17
- Comprehension and Application: 18.23 out of 23
- Higher Mental Activities: 5.17 out of 8 (#8 has been dropped)

Examination Blueprints

Each question on the examination is classified in two ways: according t the curricular content area being tested and according to the cognitive l demanded by the question. The examination blueprints illustrate the distribution of questions in January 1994 according to these classificati In the machine-scored columns, numbers without parentheses are multi choice questions and those in parentheses ( ) are numerical-response questions.

	Machine Scored			
Course Content	**Knowledge**	**Comprehension and Application**	**Higher Mental Activities**	**Examinatio Emphasis (%)**
Light	1, 3, 4, 9	2, 5, 6, (1), (2)	7, 8	16
Electric and Magnetic Fields	11, 13, 17, 19	10, 12, 14, 15, 16, 18, (3), (4)	20	18
Electromagnetic Radiation	21, 22, 25	23	24, (5)	9
Structure of Matter	26, 29, 33	27, 28, 30, 31, 32, 34, 35, (6), (7)	36, 37	20
Modern Physical Theories	40, 41, 42		38, 39	7
Examination Emphasis (%)	24	33	13	70

btest: Teacher Scored

cher Scored: 11.9 out of 21

Vritten-Response Questions
- Question 1: 3.69 out of 5
- Question 2: 2.77 out of 5
- Question 3: 2.34 out of 5
- Question 4: 3.11 out of 6

Question Number	Teacher Scored Question Description (Concept, Cognitive levels, and Process Skills)	Mark Value
1	Produce a graph of the relationship between the Doppler frequency shift and vehicle speed. Develop and use an averaging procedure to determine the carrier frequency.	5
2	Using data obtained when laser light sources create interference patterns, calculate the best estimate for the distance between the tiny pits on the surface of a compact disc.	5
3	Compare the charge-to-mass ratio of an accelerated electron to the value derived from an electron at rest. Calculate the relativistic mass of an electron and the accelerating voltage from the data collected in an experiment involving circular orbits.	5
4	Explain how to place a net positive charge on an uncharged electroscope by conduction and induction.	6
	Total	21

This examination has a balance of questions and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% or higher and that students capable of achieving the standard of excellence will obtain a mark of 80% or higher. This examination again included numerical-response questions, which students handled very well. Students achieving the acceptable standard were expected to demonstrate good communication skills in the written-response section of the examination, regardless of whether their answers were in calculation or verbal form.

Detailed comments on selected questions from the multiple-choice, numerical-response, and written-response sections follow.

Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficul
1	B	79.2	15	D	61.1	29	B	66.8
2	B	88.1	16	A	70.7	30	A	76.4
3	D	77.8	17	A	61.3	31	B	79.6
4	C	64.3	18	A	95.6	32	C	82.7
5	A	67.1	19	D	90.9	33	D	78.1
6	C	67.7	20	C	60.0	34	C	82.0
7	B	54.5	21	A	61.8	35	C	90.1
8	dropped		22	A	78.0	36	D	76.4
9	C	49.1	23	C	96.0	37	B	35.7
10	A	48.3	24	D	84.0	38	B	73.2
11	C	90.6	25	B	65.2	39	D	79.1
12	B	85.1	26	A	78.4	40	B	70.9
13	A	60.1	27	D	85.8	41	A	74.1
14	B	88.5	28	C	77.6	42	D	66.1

*Difficulty—percentage of students answering the question correctly

All students were expected to demonstrate a high level of compete in calculations. Students achieving the standard of excellence were expected to apply their knowledge to unusual problems and to use scientific generalizations effectively. Students' performance on the machine-scored sections of the examination was generally satisfact The average score for the machine-scored sections was 74.3%. Students found the knowledge and single-step application question be the easiest.

For a complete breakdown of student responses by alternative for t multiple-choice questions, please refer to the school and jurisdictio reports. The following two questions were selected for discussion because they exemplify the concepts and skills required to meet the acceptable standard and the standard of excellence. Detailed comm on the two questions follows.

9. On a sunny day, Polaroid™ sunglasses reduce glare from the surface of a lake primarily because they

A. reflect a proportion of the incident light
B. refract a proportion of the incident light
•C. absorb a proportion of the reflected light
D. absorb a proportion of the ultraviolet light

Question 9: Students had to apply their understanding of polarizin filters to explain how glare is reduced from the surface of a lake. T this, students must understand that the glare coming from the surfa the lake is light from the sun. Therefore, the glare entering the lens the sunglasses is reflected sunlight from the surface of the lake. Ne students need to recall that polarizing filters reduce the amount of l passing through them by absorbing a proportion of the light or, as i question, glare from the surface of the lake. It was expected that students would be able to recall the concept that light can be polari and that the quantity of light passing through a polarizing filter is reduced through absorption. However, of the students who achieve acceptable standard but not the standard of excellence, 44.3% answ the question correctly. Of the students who achieved the standard c excellence, 62.6% chose the correct answer. Many students contin

have difficulty applying their knowledge of physics to a real-life situation.

2. An X-ray tube produces photons by accelerating an electron through a potential difference and then having the electron collide with a metal surface. The minimum potential difference necessary to produce a photon of a wavelength of 2.0×10^{-10} m is

A. 8.3×10^{-25} V
B. 9.9×10^{-18} V
•C. 6.2×10^{3} V
D. 1.3×10^{9} V

Question 32: Students had to calculate the minimum potential difference necessary to produce an X-ray of a wavelength of 2.0×10^{-10} m. To do this, students must first recall that the X-ray is produced when an electron travelling at a high speed collides with the metal surface. In addition, they must understand that electrons can be accelerated to high speeds when in the presence of an intense electric field created by a large potential difference. However, before selecting the appropriate formulas, students must also draw on their knowledge that the energy of the electron before impact is equivalent to the energy of the photon produced and that this energy is a function of the wavelength of the photon. Students achieving either the acceptable standard or the standard of excellence continue to do well with routine single- or two-step problem-solving questions. Of the students who achieved the acceptable standard but not the standard of excellence, 79.7% answered this question correctly. Of the students who achieved the standard of excellence, 97.6% answered this question correctly. Even 42.4% of the students who did not achieve the acceptable standard chose the correct answer.

Numerical Response

Question	Answer	Difficulty*
1	3.81, 3.82	92.1
2	1.60	74.4
3	73.5	88.3
4	1.64	77.5
5	7.5	54.3
6	3.18, 3.19	76.2
7	1.42	82.1

*Difficulty—percentage of students amswering the question correctly

Most students correctly followed the instructions for filling in the answer sheet. Some students consistently rounded their answers to the incorrect number of digits, counted the decimal point as a digit, or filled in the zero instead of the decimal.

All seven questions discriminated well between those students who reached an acceptable standard and those who did not. Students achieving the acceptable standard again showed that they can generate a correct response for questions that have an open-ended format.

The following two questions were selected for discussion because they exemplify what is required to meet the acceptable standard and the standard of excellence.

4. At a distance of 2.00×10^4 m from the centre of an asteroid, the strength of the gravitational field is 2.74×10^{-2} N/kg. The mass of the asteroid, expressed in scientific notation, is $b \times 10^w$ kg. The value of b is ___________ .
(Round and record your answer to three digits.)

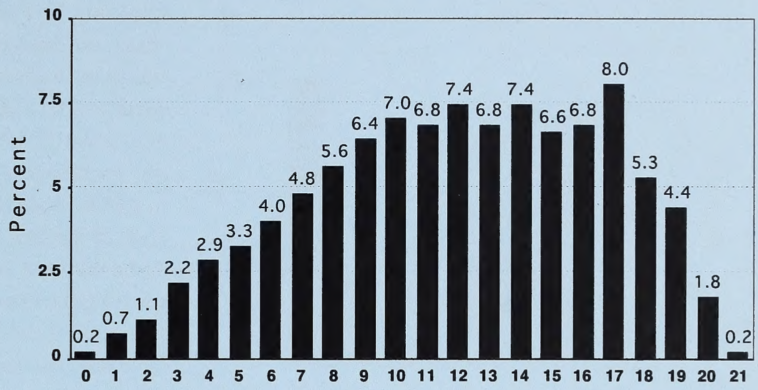
Question 4: Students had to calculate the mass of an asteroid given a gravitational field strength generated at a known distance from the centre of the asteroid. Given this theoretical data, the student must fir create an image of the scenario. From there, they must recall that gravitational field strength (g) is directly proportional to the mass and inversely proportional the square of the distance (r) measured from th centre of the mass (m), in this case, from the centre of the asteroid. Students must then identify the formula that should be used to calcula the mass of the asteroid. Students are expected to be able to substitute values into the formula and solve for the asteroid's mass. Of the students who achieved the acceptable standard but not the standard of excellence, 74.4% answered this question correctly. Of the students who achieved the standard of excellence, 93.3% answered the questio correctly.

5. A telecommunications transmitter sends out a microwave signal to a receiver and then receives it back after 1.330 s. The signal was in the receiver for 1.280 s before being returned. The distance between transmitter and receiver, expressed in scientific notation, is $b \times 10^w$ km.
The value of b is ___________ .
(Round and record your answer to two digits.)

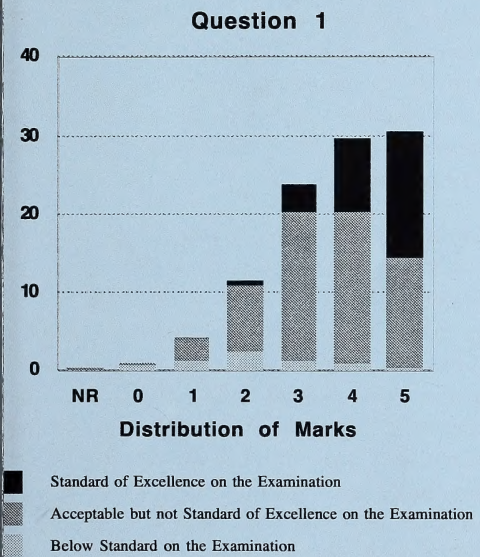
Question 5: Students had to calculate the distance between a telecommunications transmitter emitting a microwave signal and a receiver, based upon a difference in the time it takes to travel to the receiver and back, and the time the signal was in the receiver.
To answer this question correctly, students had to use the formula $\bar{v} = \frac{\bar{d}}{t}$. This looks simple enough; however, there are two important steps that students must complete before solving for distance. First, students must understand that the actual travelling time of the signal i the difference between the total time given in the question minus the time the signal is in the receiver. Secondly, students must also realize that this time is twice the time needed to calculate the distance betwee the transmitter and the receiver. Of the students who achieved the acceptable standard but not the standard of excellence, 46.2% answere the question correctly. Of the students who achieved the standard of excellence, 81.2% chose the correct answer. Only 9.2% of the studen who did not achieve the acceptable standard answered the question correctly. What may have initially looked easy to many students in reality required a deeper understanding of the application of physics.

Written Response

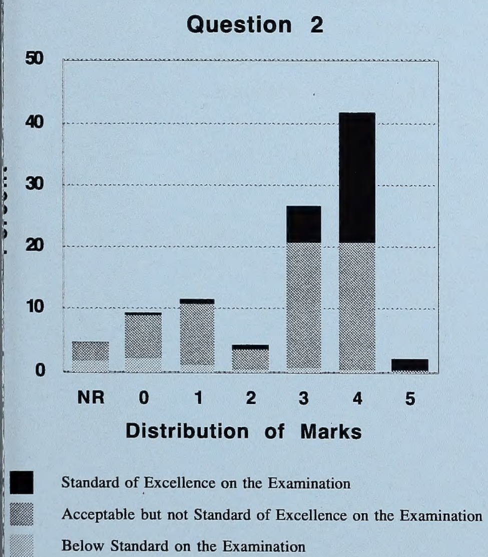
The four questions in the written-response section relate to four of the five strands for Physics 30. Responses to the written-response section indicated that students approached the examination seriously. All fou questions were attempted by 91.7% of the students and very few, 0.1%, did not attempt any of the four questions. A few students, 0.2% achieved full marks on each of the four questions. In addition, approximately 54.9% of the students obtained 11 or more marks out o 21. The average mark on the written-response section was 11.2 or 53.3% of the available marks.



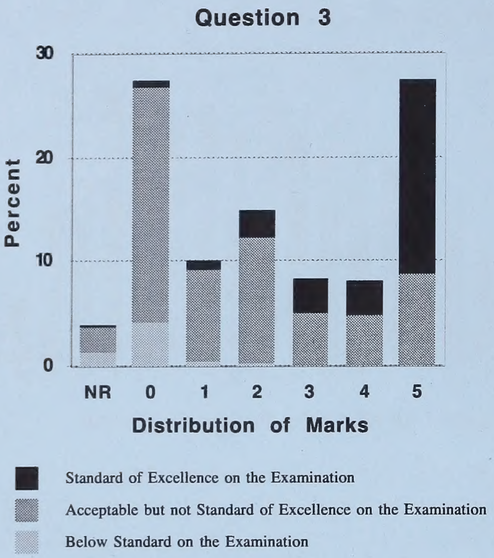
Distribution of Marks for Written Response

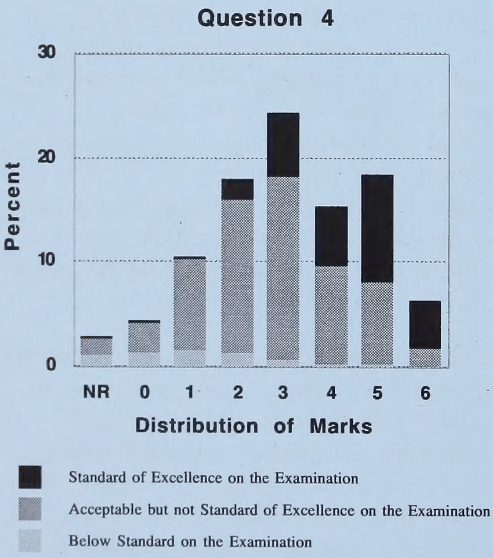


Question 1: Students were required to draw a graph of the relationship between Doppler frequency shift and the speed of a moving vehicle. Students continue to improve their graphing skills. Fewer students have problems choosing an appropriate scale and drawing the best-fit line for the data plotted. Some students, however, continue to force their best-fit line through the origin and a few students still "connect the dots" on their graph.
Students also had to use an averaging procedure to determine the carrier frequency of the detector. Most students successfully applied their understanding of slopes to calculate the carrier frequency. The average mark on this question was 3.69 out of 5 marks. Of the students achieving the acceptable standard but not the standard of excellence, 81.6% received 3 or more marks out of 5. Of the students achieving the standard of excellence, 54.6% received 5 out of 5 marks.



Question 2: Students had to use data obtained when laser light sources created interference patterns in order to calculate the best estimate of the distance between the tiny pits on the surface of a compact disc. Some students had difficulty manipulating the formula given in the data booklet to isolate *d*, the distance between the pits on the disc. Others were not able to correctly substitute the values given in the table into the formula, because they did not know what the variables in the formula represented. The average mark on this question was 2.77 out of 5 marks. Of the students achieving the acceptable standard but not the standard of excellence, 64.4% received 3 or more marks out of 5. Of the students achieving the standard of excellence, 76.3% received 4 or 5 marks out of 5.





Question 3: Part **a** required students to compare the charge-to-mass ratio given in the data booklet to the charge-to-mass ratio of an accelerated electron travelling in a circular orbit. More students than expected were unsuccessful in making the link between the increased mass of the electron and the relativistic nature of objects travelling at high speeds. In part **b**, students were expected to calculate the relativistic mass of the electron using the measured charge-to-mass ratio. Part **c** required students to calculate the accelerating voltage by equating the energy increase of the electron created by the accelerating voltage with the measured mass increase of the electron. The average mark on this question was 2.34 out of 5 marks. Of the students achieving the acceptable standard but not the standard of excellence, 47.4% received 2 or more mark out of 5. Of the students achieving the standard of excellence, 75.0% received 4 or 5 marks out of 5.

Question 4: Students were required to explain how they would place a net positive charge, first on an uncharged electroscope by conduction, and then on an uncharged electroscope by induction. In both cases, students were to assume that all materials and objects were initially uncharged and that explanations were to focus on the details related to th movement of electrons. Many students knew that a glass rod must be rubbed with silk to produce a positive charge on it, bu they did not describe the movement of charges that would occur using this procedure. The same was true of students charging a rubber rod with fur. In addition, some students provided explanations that described the movement of positive charges. The movement of positive charge continues to be a misconception for students. The average mark for this questio was 3.11 marks out of 6. Of the students achieving the acceptable standard but not the standard of excellence, 56.5% received 3 or more marks out of 6. Of the students achieving the standard of excellence, 51.1% received 5 or 6 marks out of 6.

For further information, contact Greg Hall or Phill Campbell a the Student Evaluation Branch, 427-0010.